approximation to the true theoretical shape of the arch is attained either by taking the "three-point circle," passing through the vertex A and the two points of equal curvature B_2 and B_2', or by taking the "described circle," touching at B_1 and B_1', or by taking the "inscribed circle," touching at A and again internally at B_3 and B_3' beyond the points of maximum curvature B_1 and B_1', instead of taking, as customary, the circle of curvature at the vertex; and the authors show that if an elliptical arch is described, the proper approximation to its shape is obtained from an orthogonal projection of one of these circles.

The points B_1 and B_1' are called the *noses* of the transformed catenary, and give the name to the paper.

The transformed catenary, which may be taken as the line of thrust, is shown to lie below the "described circle," and above the "three-point circle," so that by taking these or similar circles for the boundaries of the ring of the arch, the proper stability of the arch is secured.

The mathematical treatment of the Catenary given by the authors would gain considerably in elegance by the employment of the hyperbolic functions, now no longer to be disregarded; thus, instead of writing—

$$y = r\frac{m}{2}\left(e^{\frac{x}{m}} + e^{-\frac{x}{m}}\right)$$

$$\tan\theta = \frac{dy}{dx} = \frac{r}{2}\left(e^{\frac{x}{m}} - e^{-\frac{x}{m}}\right),$$

the notation—

$$\frac{y}{m} = r\cosh\frac{x}{m},\ \tan\theta = r\sinh\frac{x}{m},$$

should be employed; and for purposes of numerical calculation of these hyperbolic functions, it is only necessary to notice that if $\tan\theta = \sinh u$, $\sec\theta = \cosh u$, then $u = \text{hyp. log}(\sec\theta + \tan\theta)$; so that the table of u, already calculated by Euler, used in conjunction with the tables of the ordinary circular functions, will give us the numerical values of the hyperbolic functions; for large values of u, when θ denotes an angle being nearly a right angle, the approximate equation—

$$\log\cosh u = \log\sinh u = u\log e - \log 2$$

being sufficient.

Tables of numerical results are given at the end of the paper, with practical illustrations, for the benefit of architects and engineers, and supplementary tables are added for the immediate designing of brick, sandstone, and granite arches, with circular soffits; so that these investigations should prove decidedly useful to those engaged in the design of similar structures.

A. G. G.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xi. No. 3 (Baltimore, April 1889.)—Were it not for the size of the pages, this number might be taken to be a number of the *Mathematische Annalen*, seeing that out of its ninety-eight pages sixty-eight are written in German. The first memoir, by Oskar Bolza (pp. 195–214), is entitled "On the Construction of Intransitive Groups," and touches on points discussed by Jordan ("Traité des Substitutions"), Capelli ("Sopra l'Isomorfismo dei Gruppi di Sostituzioni"), Netto ("Substitutionentheorie"), Cayley ("Theory of Groups"), and Dyck ("Gruppentheoretische Studien"). This is followed by a short note by Karl Heun (pp. 215–20), on "Die herstellung einer linearen Differentialgleichung aus einem gegebenen Element der Integralfunction." Next we have an important memoir by Koenigsberger (pp. 221–82), "Ueber die Reduction von Integralen transcendenter Functionen." The closing note, by Dr. Franklin (pp. 283–92), "On the Double Periodicity of the Elliptic Functions," *inter alia*, proves a theorem of a bicircular quartic, enunciated by Clifford (see Crofton, L.M.Soc. Proc., vol. ii), and also results due to Siebeck and Greenhill, but all are established here from a different point of view.

Rivista Scientifico-Industriale, February 15.—Researches on the thermo-electric conductivity of magnetized iron (concluded), by Prof. Ercole Fossati. From these experiments the author concludes generally that the electric conductivity of iron either suffers no change under transverse magnetization or undergoes some increase; this increase, however, is much less than the diminished conductivity of iron magnetized in the longitudinal direction. This inference agrees perfectly with the deductions he had already arrived at experimenting with iron conductors of varying dimensions.—Some experiments with a new battery, by Prof. Augusto Righi. Excellent results have been obtained from the battery here described, which consists of 108 condensers disposed in six groups of eighteen each, one above the other, in order to obtain high potentials. The outer armatures communicate with the conductors of a Holtz machine, the central with the ground, and a capacitity is thus obtained equal to that of $\frac{18}{6} = 3$ jars, united in a single battery with armatures communicating directly with the two conductors of the machine. The capacity of the whole system is thus 18,810 electrostatic units, or about $\frac{1}{48}$ microfarad.

Rendiconti del Reale Istituto Lombardo, February 28.—Notice of the late Prof. Giuseppe Meneghini, by Prof. T. Taramelli. In this biographic memoir a summary account is given of the services rendered to geological studies by the eminent naturalist, who was born in Padua in 1811, and died in January of the present year. Meneghini is best known as joint translator, with Savi, of Murchison's work on the Alps, Apennines, and Carpathians, and by his systematic monograph on the fossils of the Upper Lias in Lombardy and Central Italy. His last publication was a paper on the Cambrian trilobites of the Iglesiente district, and his name will always be associated rather with the palæontological than the stratigraphic or petrographic side of geology.—Meteorological observations made at the Royal Brera Observatory, Milan, during the month of February.

THE last issue of the *Memoirs of the St. Petersburg Society of Naturalists* (vol. xix., Botany) contains, besides several very interesting short papers in the Proceedings, a new contribution to the flora of Novgorod, by A. Antonoff, which raises the number of species of flowering plants discovered in the Government of Novgorod to 700; a note on the comparative anatomy of the tissues in the leaves of *Salicineæ* as a basis for classification, by V. Dobrovlanski; and a suggestive description of the flora of the Shenkursk and Kholmogory districts of Archangelsk, by N. Kuznetsoff. Owing to the extension of a subsoil of limestone, which is much warmed by the sun during the summer, the flora of the region contains a number of species belonging to a more congenial climate, while several species characteristic of those latitudes are wanting. On the other hand, owing to its proximity to the Urals, and the existence on the west of such a barrier as Lake Onega, the flora contains a considerable number of Siberian species, while many West European species do not appear. M. Kuznetsoff's remarks on the extension of the *Abies sibirica*, which is slowly advancing towards the West, and the lime-tree, which seems to be, on the contrary, disappearing, are very interesting. Both the *Ulmus campestris* and the *U. effusa* were found as far north as the sixty-third degree of latitude. The presence of the *Lymnanthemum nymphoides*, which is found in Lithuania and South-Eastern Russia, but not in Central Russia, save Kursk, is especially remarkable, and M. Kuznetsoff explains the extension of this aquatic plant over Archangelsk by its having spread along the canal which connects the Volga with the Dvina. No fewer than twelve other South Russian plants, which must have migrated along the same canal, are named by the author. As to the *Mulgedium tataricum*, C. A. Mey., which is characteristic of the salt steppes of Astrakhan, it has been found on a shoal of the Dvina, under 64° N. lat. The paper is accompanied by a map, showing the western limits of extension of the *Abies sibirica*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 14.—"On the Organization of the Fossil Plants of the Coal-Measures. Part xvi." By W. C. Williamson, LL.D., F.R.S., Professor of Botany in the Owens College, Manchester.

In this memoir the author first calls attention to detached observations, made in his earlier memoirs, relating to the manner in which a medullary axis is developed in the interior of each of the primary vascular bundles of the Carboniferous Lycopodiaceæ. He then traces the changes undergone during the development of a small branch-bundle in *Lepidodendron Harcourtii*.

This is followed by a description of a small new species of Lepidodendron.

In a second new species, named *Lepidodendron intermedium*, an apparently early form of exogenous zone is shown to exist. When describing, in his previous memoir, Part xi. (see Plate 49, Fig. 11), the stem now designated *Lepidodendron fuliginosum*, he showed that, in it, we have an example of the most rudimentary and least perfectly developed form of an exogenous xylem yet seen amongst these Carboniferous Cryptogams. In this example, but a few radiating laminæ of vascular tissues make their appearance in the innermost cortex. In the plant now described, though these few laminæ are represented by a continuous cylindrical zone of tracheids, and though the laminæ are arranged in radial order, they are still embedded in a mass of cellular tissue, much in excess of what constitutes the medullary rays in the higher types of Lepidodendroid organization.

A fourth new species of Lepidodendron is described, under the name *L. Spenceri*, in young states of which no medulla is visible, but, in its place, a number of vertically elongated cells and imperfectly lignified scalariform tracheids are seen, inclosed within an outer series of perfectly lignified tracheids.

A fifth new species, *Lepidodendron parvulum*, is also described; after which the author points out the differences between the mode of development of the cellular medulla of these exogenous Cryptogams, and that of the representative organ among the Dicotyledonous Exogens. Amongst the ordinary Exogens, the growing tip of a stem or branch is a mere aggregation of cells, which mass is soon separated into two zones by the development within it of a ring of vascular bundles. The cells inclosed within this ring become the medulla, and those external to it constitute the cortex. Such a pith subsequently undergoes but a very limited enlargement. In most cases a time arrives when it grows less with age, and ultimately disappears; but in the Lepidodendra, though the tip of each growing stem was, in the first instance, also a cellular mass, an axial solid bundle of vessels was developed in the centre of the new growth almost at its very commencement. But it was only after this growth had made some progress, and the twig had become clothed externally with numerous leaves, that the first traces of a medulla began to appear in the centre of the bundle. It is thus clear that the medulla of these Carboniferous Lycopods is not genetically homologous with that of an ordinary exogenous flowering plant.

The axial vascular medullary bundle expanded into a hollow cylinder under the internal pressure of the growing medulla, which latter not only attained to considerable dimensions, but was a persistent organ. The ring inclosing the medulla supplied all the vascular bundles going to leaves and in part to branches. The author demonstrates that the branches are supplied with such bundles in two ways; when the growing stem divides dichotomously, which it does as amongst living Lycopods, the medullary vascular cylinder splits into two equal halves. But, besides this mode, the author shows that very frequently comparatively small segments are cut completely out of the vascular cylinder, in which a gap is thus left where the bark and the medulla meet. The angular segment thus detached develops into a solid cylindrical bundle, in which, in time, a medulla forms as before. The author is inclined to believe that all these latter forms of bundles only supply short abortive lateral branches, which most probably supported Lepidostrobous fruits.

March 21.—"On the Velocity of Transmission through Sea-water of Disturbances of Large Amplitude caused by Explosions." By Richard Threlfall, M.A., Professor of Physics, and John Frederick Adair, M.A., Demonstrator of Physics, University of Sydney. Communicated by Prof. J. J. Thomson, F.R.S.

This paper contains an account of a large number of experiments made with the object of determining the velocity of waves of compression caused by explosions under water.

The method adopted depended on the use of a certain "gauge" devised for the occasion, whereby the arrival of the disturbance at a given point was transmitted to a chronograph.

The disturbances themselves were caused by submarine explosions of dynamite and gun-cotton in quantities varying from nine ounces to four pounds.

The distance over which the velocity was measured was about 200 yards.

The water was that of the Pacific Ocean in the harbour of Port Jackson, New South Wales.

The chronograph was of the falling pendulum description, and fired the charge automatically.

The absolute time was obtained by comparing the chronograph tuning-fork with an astronomical clock.

The distance was obtained in terms of the standard yard of New South Wales by means of trigonometrical survey. The chief results for the range quoted are as follows:—

Class.	Description of explosive.	Number of experiments (each experiment involving two explosions and time measurements).	Velocity found in metres per second.	Temperature C.	Velocity of sound calculated in metres per second.	Excess of velocity as compared with velocity of sound.
						per cent.
A	9 oz. dry gun-cutton	11	1732 ± 22	17°·8	1523	13·75
B	10 oz. No. 1 dynamite	24	1775 ± 27	14·5	1508	17·7
C	18 oz. dry gun-cotton	5	1942 ± 8	18·3	1525	27·3
D	64 oz. dry gun-cotton	3	2013 ± 35	19·0	1528	31·7

The chief portion of the paper is occupied in the description of the details of the precautions taken to make the measurements as accurate as possible. This involves some chronographic improvements. An explanation of the large observed velocity is attempted.

"On an Effect of Light upon Magnetism." By Shelford Bidwell, M.A., F.R.S.

Several experimenters in the early part of the present century tried to magnetize iron and steel by the action of light,[1] but I do not know of any recent attempts in this direction, and of late years the thing has been generally regarded as impossible. Under ordinary circumstances there can be little doubt that this is the case, but, if a certain condition is fulfilled, we might, I think, expect to find some evidence of the action of radiation upon the magnetism of iron.

The condition is that the susceptibility of the bar AB to be operated upon shall be greater (or less) for a magnetic force in the direction AB than for an equal one in the direction BA. This paper contains a short preliminary account of a series of experiments which have been undertaken with iron bars having this property. Much yet remains to be done, which will require a considerable amount of time, and for which special apparatus must be constructed. In the meantime, the results already obtained appear to possess sufficient interest to justify their publication.

The method of preparing the bars is as follows. A piece of soft iron rod, which may conveniently be 10 or 12 cm. long and from 0·5 to 1 cm. in diameter, is raised to a bright yellow heat and slowly cooled. When cold, it is placed inside a solenoid, through which is passed a battery current of sufficient strength to produce a field of about 350 or 400 C.G.S. units. The iron when removed from the coil is found to be permanently magnetized, and its north pole is marked for the sake of distinction with red sealing-wax varnish. The bar is then supported horizontally and in an east and west direction behind a small reflecting magnetometer, and over it is slipped a coil, which is shunted with a rheostat, the resistance of which can be gradually increased from 0 to 26 ohms. The coil can be connected by a key with a single battery cell, which is so arranged as to produce a demagnetizing force inside the coil. The resistance of the rheostat is slowly raised, so that more and more current passes through the coil, the battery key being alternately lifted and depressed until the magnetometer indicates that the iron bar as a whole is perfectly demagnetized. The strength of the demagnetizing force required varies according to circumstances: it is generally about one-thirtieth or one-twenty-fifth of the original magnetizing force.

After this treatment the iron rod does not differ, so far as ordinary tests will show, from one which has never been submitted to magnetic influences. Nevertheless, as is well known, it possesses certain properties which distinguish it from a piece of really virgin iron. In the first place, the magnetization induced by a force acting in such a direction as to make the marked end a north pole is greater than that caused by an equal force in an opposite direction. Again, if such a bar be held horizontally east and west (to avoid terrestrial influences), and tapped with a mallet, the marked end at once becomes a north pole. A similar effect follows if the rod be warmed in the flame of a spirit-lamp. Lastly, if it be placed inside a coil and subjected to the action of a series of rather feeble magnetic forces, of equal strength but alternating in direction, the marked end will generally become a north pole, even though the last of the alternate forces may have tended to induce the opposite polarity.

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[1] Chrystal, "Encyclopædia Britannica," vol. xv. p. 274, mentions the following names: Morichini, Mrs. Somerville, Christie, Riess, and Moser.

A rod treated as above described appears to be remarkably sensitive to the action of light. When such a rod is placed behind the magnetometer, and illuminated by an oxyhydrogen lamp about 70 cm. distant, there occurs an immediate deflection of from 10 to 200 scale-divisions,[1] the magnitude of the effect varying in different specimens of iron. As the action of the light is continued, the deflection slowly increases. When the light is shut off, the magnetometer instantly goes back over a range equal to that of the first sudden deflection, then continues to move slowly in the backward direction towards zero.

The first quick movement I believe may be due to the direct action of radiation, and the subsequent slow movement to the gradually rising temperature of the bar. With a thick rod (1 cm. in diameter) the slow movement is barely perceptible, extending over only one or two scale-divisions in the course of a minute, the spot of light becoming almost stationary after the first sudden jump. With a thin rod the sudden effect is generally smaller, while the slow after-effect is greater, and may continue until the spot of light passes off the scale.

As a general rule the magnetic effect is such as to render the marked end of the rod a north pole: occasionally, however, it becomes a south pole, but in such cases I have always found that the polarity is comparatively feeble. It may even happen[2] that the marked end becomes north when certain portions of the rod are illuminated, and south when the light acts upon other portions. This is probably due to irregular annealing and a consequent local reversal of the direction of maximum susceptibility: it indicates that the light effect is local, and is confined to the illuminated surface. In one remarkable specimen, which happens not to have been annealed at all, the sudden effect and the slow effect are in opposite directions. When the light is turned upon this rod, there is at first a sudden deflection of twenty magnetometer-scale-divisions to the left, the spot afterwards moving slowly and steadily towards the right. When the light is shut off there occurs at once a jump of twenty divisions further towards the right before the spot begins to move back in the zero direction.

Some attempts have been made to repeat the experiments with light polarized by means of a Nicol's prism; but, either because the largest prism at my disposal was too small (its aperture being barely 2 cm.), or because too much of the radiant energy was absorbed by the spar, I failed to get any magnetic effects whatever with the prism in either position.

[Prof. Silvanus Thompson has quite recently been kind enough to lend me a very large and excellent Nicol's prism. From a few experiments already made with this instrument it appears that the action of the light is quite independent of the plane of polarization.]

There can be no doubt whatever of the reality of the effects here described: they are perfectly distinct, and are at any time reproducible with certainty. The only question is how much of them is primarily caused by the action of light, and how much by mere incidental change of temperature. But, taking all the circumstances into consideration, I think the evidence is in favour of the conclusion that the *instantanecus* magnetic change, which occurs when a prepared iron bar is illuminated, is purely and directly an effect of radiation.

Physical Society, March 23.—Prof. Reinold, President, in the chair.—Prof. J. V. Jones read notes on the use of Lissajous's figures to determine a rate of rotation, and of a Morse receiver to measure the periodic time of a reed or tuning-fork. In determining resistance absolutely by the B.A. or by Lorenz's method, it is important to know the speed of rotation at the instant when the deflection of the galvanometer needle is observed. To determine this, an arm carrying a mirror is caused to oscillate by a pin placed eccentrically in the end of the spindle, and a Lissajous's figure is obtained by using another mirror mounted on a vibrating reed driven electrically. Equality of period is obtained when the resulting elliptical figure is permanent, and the frequency of the reed is determined subsequently. In making the experiments it is found convenient to control the speed of the disk by braking it either with the finger or a piece of wood. The reed consists of a rectangular steel rod, 100 centimetres long, and section 1·51 × 0·60 centimetres, and the length of the vibrating segment can be altered by sliding it through a clamp. To permit of this change without altering the electrical contacts, the latter are formed by two independent springs, one of which is always in contact with the rod. For determining the frequency of the reed a second pair of contacts are operated by the vibrator and the currents recorded by a Morse receiver, whilst simultaneously the paper receives marks from a pen controlled by a standard clock. The limit of accuracy of this part of the experiment is found to be $\frac{1}{10}$ per cent., due to changes in the reed's frequency. This is a serious defect, and the author of the paper asked for advice as to the precautions necessary to obtain reeds of constant pitch. Prof. Ayrton, whilst recognizing the extreme importance of determining speed accurately, suggested that the inconstancy of the reed may be due to the impulse being given at the end instead of the middle of its swing, and recalled an experiment, shown before the Society by Prof. Perry and himself, in which the pitch of an electrically driven fork was varied greatly by altering the adjustment of the contact screw. Referring to Dr. Thompson's modification, where two tuning-forks drive each other, it was pointed out that the method requires the synchronism of the two forks to be very exact. Mr. Blaikley inquired whether any doors were opened or closed during the experiments, as the pitch of a reed is affected by the size of its resonance chamber. He also stated that the pitch of reeds driven pneumatically could be maintained constant to 1 part in 10,000, and mentioned that two forks nearly in unison influence each other's period when near together. Referring to the two forks mentioned by Prof. Ayrton, Prof. S. P. Thompson said it was advantageous to mount such forks on sounding boxes, for when placed at a suitable distance apart they then exert considerable mutual control. The sketch put on the board by Prof. Jones led Dr. Thompson to suppose that a perfect method of driving forks had been devised, for two springs were shown touching opposite sides of the bar, and such an arrangement might be used to complete the circuit, only when the reed is in the middle position. He also believed that forks give greater constancy than single reeds, and mentioned some recent improvements, in which one prong of an electrically driven fork is made of phosphor bronze. Mr. T. H. Blakesley, reasoning from ideas suggested by Mr. Stroh's experiments on vibrating membranes, concluded that the periods of forks, placed at $\frac{1}{4}$ wave-length apart, would not influence each other. In reply to a question from Mr. F. J. Smith, Prof. Jones thought there could be no "creeping" of the reed through the clamp. He also stated that he had been led to use a reed from the results obtained in Delaney's system of telegraphy, and the fact that Lord Rayleigh considered electrically driven forks satisfactory.—Dr. Hofford read extracts from the following papers:—On the Clark cell as a source of standard currents, by Prof. R. Threlfall and Mr. A. Pollock. The authors find, contrary to ordinary ideas, that Clark cells can be used to send currents of considerable magnitude without the E.M.F. being appreciably changed, and have constructed cells which give 0·001 amperes steadily for half an hour. This result has been obtained by increasing the size of the cell so that each electrode is about 5 square inches in area, and the internal resistance is about 6 ohms. For the ordinary small test-tube cell, the resistance of which may be about 1500 ohms, the current ought not to exceed 0·00001. On closing the circuit the P.D. (potential difference) drops almost instantaneously to its steady value, and when the circuit is opened rises equally rapidly to very nearly the original E.M.F. The cells completely recover in time. If the current sent be too large, the P.D. falls for a time, and afterwards rises and tends towards a fixed value. In this respect Clark's cells are greatly superior to large Daniell's, sending currents through the same resistance. The paper contains several tables and curves, as well as valuable results respecting the close agreement between the E.M.F.'s of a great number of different cells.—On the application of Clark's cell to the construction of a standard galvanometer, by Prof. R. Threlfall. A large cell, as above mentioned, together with a known platinoid resistance, are used to standardize a reflecting galvanometer, constructed with a single movable coil, sliding in guides so as to vary the constant in known proportions. Two controlling magnets are carried on opposite sides of a sleeve sliding on a central tube, inclosing the long fibre, and a small hollow copper cylinder in oil acts as damper. The tangent law was found by calculation to be practically correct up to 15°, and the scale is curved so as to read tangents on a scale of equal divisions. To give this result the approximate polar equation to the curve is shown to be $r = f(1 + 0{\cdot}207\theta^2 + 0{\cdot}0269\theta^4)$. In standardizing the instrument a known current is sent through it from the Clark cell, and the controlling magnets adjusted till the spot comes to a fiducial mark on the scale. By varying the position of the coil, currents ranging from 0·001 to 0·4 ampere, can be measured. —On the measurement of high specific resistances, by Prof. Threlfall. The chief points dealt with are, the means for producing thin plates of material of known dimensions, the form and methods of magnetizing the needles, and the arrangement of suspension found necessary when great sensibility is required. For producing the plates, two plane platinized brass slabs are used, and kept at a known distance apart by micrometer screws, whilst the material is melted between them. The screws are then withdrawn, and the resistance determined by comparison with a megohm, using different E.M.F.'s in the two cases so as to obtain about equal deflections. As regards the galvanometer, after many unsatisfactory attempts to use one made according to the Messrs. Gray's pattern, the coils of that instrument were mounted in the ordinary way, and used with an astatic combination of magnetized steel disks. Extreme care was taken to obtain disks exactly similar, and a pair of electro-magnets were made to magnetize them *in situ*, so as to obtain great astaticism. For suspending the magnets, quartz fibres were found greatly superior to silk, the zero of the instrument being very indefinite, even with a silk fibre 30 inches long. Considerable difficulty was experienced in attaching the mirror to the needle on account of the distortion produced by ordinary cements; slow drying white paint was ultimately used and found satisfactory.—On the measurement of the resistance of imperfectly purified sulphur, by Prof. Threlfall and Mr. A. Pollock. The apparatus used is described in the previous paper, the galvanometer of 16,000 ohms being arranged to give one division for 2×10^{-12} amperes. A mean of the results obtained gives about 11×10^{13} ohms per cubic centimetre as the specific resistance. In performing the experiments many precautions were required to prevent air currents and magnetic disturbances, and paraffin keys were found to give much better insulation than ebonite ones. In conclusion, the authors enumerate the chief points to which attention should be paid in designing and using very sensitive galvanometers. They consider it desirable to use quartz fibres at least 6 feet long, to provide very fine adjustment for the controlling magnets, whose supports should be independent of the suspension arrangement, and believe that the whole should be placed in a thick soft iron cylinder. Mr. Boys, speaking of attaching mirrors to wires, said he found a very small speck of shellac varnish to be very satisfactory. As regards quartz fibres, Prof. Threlfall's method of producing them differed materially from his, and the fibres were much thicker. He considered it quite unnecessary to use fibres anything like 6 feet long, and thought 15 inches quite sufficient where the weight to be supported was not large. Prof. Ayrton regarded the results obtained from Clark's cells to be of extreme scientific and commercial importance, for they showed that a very convenient standard of E.M.F. could also be used as a standard for current. Prof. Thompson, after commenting on the convenience of good E.M.F. standards, expressed a hope that Prof. Threlfall would be able to suggest a convenient method for producing a standard ampere.

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[1] The magnetometer mirror was 1 metre distant from the scale, and each division = 0·64 mm. ($\frac{1}{40}$ of an inch).

[2] This has been observed in two specimens.

Royal Meteorological Society, March 20.—Dr. W. Marcet, F.R.S., President, in the chair.—Dr. Marcet delivered an address on "The Sun: its Heat and Light," in which he said that the source or origin of all meteorological phenomena is the sun, which sends or radiates its heat to the earth through the molecular vibration of the invisible matter connecting earth with space. If there were no air and moisture we should feel the sun's heat to a much greater extent. After the sun's rays have reached the earth, a portion of the heat they bring with them is absorbed by the earth and terrestrial objects, another is converted into motion, and a third is reflected into space. After describing the various actinometers and other instruments used for determining the amount of solar radiation, Dr. Marcet showed that the temperature of the solar rays falls rapidly when tested at increasing altitudes in a balloon. He then gave an account of some observations made by Mr. Glaisher in the celebrated balloon ascent which he and Mr. Coxwell made at Wolverhampton on September 5, 1862, when they reached a height of about seven miles above the earth's surface. Regarding the transformation of solar heat into motion, a very interesting illustration is afforded by the radiometer, in which the direct influence of the sun's rays causes a light vane to rotate; while another illustration of the mechanical effects of heat upon fluids is their conversion into what is known as the spheroidal condition. In connection with this Dr. Marcet explained how by wetting his hand he could pass it through molten lead without injury. He also related the case of Henry Hall, one of the keepers of the Eddystone Lighthouse, who, on the occasion of the fire which destroyed the lighthouse on December 4, 1755, accidentally swallowed some molten lead, but did not die till several days afterwards, when a piece of lead was taken out of his stomach. Dr. Marcet then briefly drew attention to the sun's light, stating that the passage of the sun's light through our atmosphere alters it in kind to a great and remarkable extent. Light can be decomposed into its elementary colours. In connection with this branch of the subject Dr. Marcet performed a number of experiments, including, among others, that of passing a ray of light through a glass freed from dust, when the ray disappears within the vessel, but reappears on the other side, showing that the power to form light was there, though not the material for this power to act upon. Dr. Marcet concluded his very interesting address by describing the various forms of sunshine recorders.—The meeting was then adjourned in order to afford the Fellows and their friends an opportunity of inspecting the Exhibition of Instruments opened on the previous evening. A full account of this Exhibition has already been given on p. 523.

Geological Society, March 20.—W. T. Blanford, F.R.S., President, in the chair.—The following communications were read:—Supplementary note to a paper on the rocks of the Atlantic coast of Canada, by Sir J. W. Dawson, F.R.S.—The occurrence of colloid silica in the Lower Chalk of Berkshire and Wiltshire, by Mr. W. Hill and Mr. A. J. Jukes-Browne.—Note on the pelvis of *Ornithopsis*, by Prof. H. G. Seeley, F.R.S. The remains preserved in Mr. Leed's collection at Eyebury, and described by Mr. Hulke, are the largest and most perfect pelvic bones of a Saurischian known in this country. An examination showed that the bones of the right and left sides were united in the median line almost throughout their length by a median suture, and that they formed a saddle-shaped surface internally from front to back. After giving a detailed description of the pubis and ischium, the author stated that he was not aware that this type of pelvis had been previously observed. He noted that the antero-posterior concavity between the anterior symphysis of the pubic bones and the posterior symphysis of the ischia was a well-marked characteristic of Saurischian reptiles, but that it remained to be determined to what extent the median union of the pubic bones was developed in the group. It was impossible to judge of the form of the ilium from the imperfect fragment preserved, but it did not make any recognizable approximation to the bone in those American genera which offered the closest resemblance of form to the pubis and ischium. There were several minor differences of proportion between the bones from the Oxford Clay and those from the Wealden of the Isle of Wight, and the former differed in ways pointed out from *Morosaurus*, *Diplodocus*, and *Brontosaurus*, though there were resemblances.

Zoological Society, March 19.—Prof. Flower, F.R.S., President, in the chair.—The Secretary read a list of the fishes collected at Constantinople and sent to the Society by Dr. E. D. Dickson. The species were sixty-six in number, and had been determined by Mr. G. A. Boulenger.—Mr. Tegetmeier exhibited a female Gold Pheasant in male plumage, and a curiously distorted pair of horns of the Ibex of Cashmir.—The Rev. A. H. Cooke read a paper on the position of the land-shells of Australia and the adjacent islands, commonly referred to the genus *Physa*, which it was shown (mainly from an examination of the *radula*) were really more nearly allied to the genus *Limnæa*. Mr. Cooke proposed to refer these species to the genus *Bulinus*, established by Adanson in 1757.—Mr. G. A. Boulenger read notes on some specimens of Lizards belonging to the Zoological Museum of Halle, which had been sent to him for examination. To these notes were appended revised descriptions of two Lizards from the Argentine Republic, *Cymnodactylus horridus* and *Urostrophus scapulatus*.—A communication was read from Prof. W. N. Parker, containing an account of the occasional persistence of the left posterior cardinal vein in the Frog. This condition, abnormal in the Frog, was shown to be essentially normal in *Protopterus*.—A communication was read from Mr. J. Douglas Ogilby, containing notes on some fishes new to the Australian fauna.—Mr. Oldfield Thomas read a paper giving the description of a new Bornean Monkey belonging to the genus *Semnopithecus*, obtained by Mr. Charles Hose on the north-west coast of Borneo. The author proposed to name it *Semnopithecus hosei*, after its discoverer.

April 2.—Prof. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of March 1889, and called attention to a specimen of the Manatee (*Manatus australis*), purchased March 2, being the second example of this Sirenian obtained alive by the Society; to an Oriental Phalanger (*Phalanger orientalis*, var. *breviceps*), presented by Mr. C. M. Woodford, of Sydney; and to a specimen of Owen's Apteryx (*Apteryx oweni*), presented by Captain C. A. Findlay.—Mr. Smith-Woodward exhibited and made remarks on a maxilla of the early Mesozoic Ganoid *Saurichthys*, from the Rhætic formation of Aust Cliff, near Bristol.—A communication was read from Mr. W. K. Parker, on the osteology of *Steatornis caripensis*. The conclusion arrived at as regards the affinities of this isolated form of birds was that *Steatornis* is a waif of an ancient avifauna, of which all the near allies are extinct, and that *Podargus* of Australia is its nearest surviving relative.—Mr. Oldfield Thomas read some preliminary notes on the characters and synonymy of the different species of Otter. The author gave a revised synonymy of the four species of *Lutra* recognized as belonging to the Palæarctic and Indian Regions, and of the two found in the Æthiopian Region. The American Otters, for want of a larger series of specimens, could not at present be satisfactorily worked out.—Mr. E. T. Newton read a paper, entitled "A Contribution to the History of Eocene Siluroid Fishes." Mr. Newton observed that spines of Siluroid fishes from the Bracklesham Beds were described by Dixon in his "Fossils of Sussex" (1850), and referred to the genus *Silurus*. Mr. A. Smith-Woodward had recently shown good reason for referring these specimens, and certain cephalic plates from the same horizon, to the tropical genus *Arius*. The greater part of a skull, from the Eocene Beds of Barton, in the Museum of the Geological Survey, confirmed the latter generic reference. Its close resemblance to a skull of *Arius gagorides* in the British Museum left no room for questioning their generic relationship, while at the same time the fossil differed from any known species of *Arius*. The fortunate discovery of one of the otoliths within the fossil skull, and its resemblance in important points to that of *A. gagorides*, still further confirmed this determination. Some other otoliths from Barton, and one from Madagascar, were also referred to the genus *Arius*.—Mr. A. Smith-Woodward read a note on *Bucklandium diluvii*, a fossil from the London Clay of Sheppey, noticed by König, and hitherto not satisfactorily determined. It was shown that this fossil was a portion of the skull of a Siluroid Fish allied to the existing genus *Auchenoglanis*.—A communication was read from Mr. H. W. Bates, F.R.S., containing descriptions of new species of the Coleopterous family Carabidæ, collected by Mr. J. H. Leech in Kashmir and Baltistan.—A second communication from Mr. Bates gave descriptions of some new species of the Coleopterous families Cicindelidæ and Carabidæ, taken by Mr. Pratt at Chang Yang, near Ichang, in China.

PARIS.

Academy of Sciences, April 1.—M. Des Cloizeaux, President, in the chair.—On regulating the velocity of a dynamo-electric machine serving as a receiver in the transmission of force by electricity, by M. Marcel Deprez. The case is first considered of the magnetic field and of the electromotive force of each machine, which are shown to be functions of the intensity of the general current only when the inducting electros are disposed in a simple series in the principal circuit. Cases are then discussed in which the receiver has a constant magnetic field, and in which the field of the generator is constant.—On the biorthogonal reduction of a lineo-linear form to its canonical form, by Prof. Sylvester. Taking F as a lineo-linear function of two series of letters—

$$x_1, x_2, \ . \ . \ . \ , x_n \ ; \ \xi_1, \xi_2, \ . \ . \ . \ , \xi_n \ ;$$

then F will contain n^2 terms. By subjecting the letters x and ξ respectively to two independent orthogonal substitutions, arbitrary quantities are introduced into the transformed form $n^2 - n$, so that by giving them suitable values we should be able to get rid of this number of terms while retaining the n pairs alone, whose arguments will be, for instance,

$$x_1\xi_1, \ x_2\xi_2, \ . \ . \ . \ x_n\xi_n.$$

Prof. Sylvester here calls the multiples of these arguments the *canonical multiplicators*; he gives the rule for determining them, and at the same time for finding the two simultaneous orthogonal substitutions which lead to the canonical form.—On the progress of the Suez Canal, and its state in the year 1888, by M. de Lesseps. Of the works undertaken to widen the Canal from 22 to 65, 75, and in some places even 80 metres, some have already been completed, and for a distance of about 15 kilometres from Port Said vessels have now ample space for passing each other. The depth will be increased to 8·50, and ultimately to 9 metres, and navigation by night is facilitated by luminous buoys and tow-paths, the light being obtained by means of compressed gas. All the sidings have been widened to 100 metres between Suez and Port Said, thus allowing six large vessels to be shunted at the same time in all of them. Ships using the electric light are now able to traverse the Canal in about twenty hours, the time hitherto required being from thirty-five to forty hours. In 1888 the Canal was traversed by 3440 vessels of 6,640,832 tons (2625 of 5,223,254 tons, British), yielding to the Company 65,102,000 francs in tolls, &c.—On an aperiodic balance with direct readings of the last fractional weights, by M. P. Curie. The instrument here described, and illustrated with a vertical section and a general view, has been constructed for the purpose of increasing the rapidity and accuracy of weighing operations in scientific and industrial laboratories.—On transformation and equilibrium in thermodynamics, by M. P. Duhem. It is pointed out that the "new function" spoken of by M. Gouy in a recent communication (*Comptes rendus*, cviii. p. 507), had already been anticipated by Mr. J. W. Gibbs, in 1873, whose views were later explained by M. Duhem in his work on the thermo-dynamic potential.—On the difference of potential at contact of a metal and of a salt of the same metal, by M. H. Pellat. The author's researches lead to a general law thus expressed: The difference of normal potential between a metal and the solution of a salt of the same metal is nil. It also follows that the difference of potential of two salts of the same acid and of different metal at contact, increased by the difference of potential of these metals placed in contact, is proportional to the quantity of heat liberated by the substitution of one of the metals for the other in the salt of the acid in question.—On telephonography, by M. E. Mercadier. The problem of telephonography—that is, the transmission of sound to distances by telegraph lines, for instance—is here studied in connection with the recent improvements of the phonograph by its inventor, Mr. Edison, and by Mr. S. Tainter (graphophone). M. Mercadier's process, which shows good results even with inferior instruments, appears to be much simpler than that by which Mr. Edison has lately succeeded in communicating along the wires between New York and Philadelphia, using for the purpose his new improved phonograph.—Papers were contributed by M. F. Beaulard, on the double elliptical refraction of quartz; by M. Woukoloff, on the law of the solubility of gases; by M. René Drouin, on succinamic nitrile; by M. Albert Colson, on the artificial and natural alkaloids; by MM. P. Langlois and Ch. Richet, on the strength of the respiratory function as affected by anæsthetics; by M. Abel Dutartre, on the action of the poison of the land salamander (*Salamandra maculosa*); and by M. Haug, on the Lias formations in the sub-Alpine ranges between Digne and Gap.

BERLIN.

Meteorological Society, March 12.—Prof. von Bezold, President, in the chair.—Dr. Wagner spoke on the connection between cosmic and meteorological phenomena. After a short review of the earlier attempts to connect meteorological phenomena with the rotation of the sun or with the phases of the moon, he passed on to a consideration of Prof. von Bezold's recently published work, in which it is shown that the storms in Bavaria and Würtemberg have a distinctly recurrent periodicity of 26 days, corresponding to the period (25·84 days) of the sun's rotation. In opposition to this, Köppen had found from his own calculations, based on more extensive data, that the storms are recurrent with a periodicity of 29 and not 26 days, thus corresponding to the synodical period of the moon. The speaker had himself investigated the periodicity of storms, not only in Bavaria and Würtemberg, but also in Baden, keeping the observations of lightning separate from those of mere rain-storms: this seemed to be necessary, not only inasmuch as von Bezold did not take any account of lightning, but also because the occurrence of lightning at the time of new moon, or during the last quarter of the moon, might give rise to apparent maxima resulting from purely optical causes. He found that the storms possess a periodicity of 29 days, which include three maxima, the chief of these being in the last half-quarter, the next at new moon, and the least at full moon. No physical explanation, or even any idea of any connection between the storms and the phases of the moon, can at present be given.—Dr. Assmann gave an account of a phenomenon which had been observed on the trees in the Thiergarten as a result of the recent heavy snow-fall. The masses of snow which were piled up high on the branches of the trees had slipped down round their sides and hung down like curtains; they possessed a not inconsiderable consistency and glacier-like structure. The superficial thawing which occurred daily about midday had contributed largely to bring about the modification which the snow had undergone.

Physiological Society, March 15.—Prof. du Bois-Reymond, President, in the chair.—Dr. Benda spoke on multinuclear mammalian spermatozoa, and refuted a number of objections which had been raised to his views on spermatogenesis.—Prof. Gad gave an account of experiments which Dr. Piotrowski had made under his direction, on the difference between the conducting power of nerves and their irritability. It was known that under certain conditions, as, for instance, when a nerve is dying or is surrounded by an atmosphere of carbonic acid gas, its power of conducting impulses shows no change, while at the same time the irritability of that part which is surrounded by the gas has disappeared. After confirming the above by renewed experiments, Dr. Piotrowski found that when he surrounded a small stretch of the sciatic nerve with alcohol vapour he obtained a result exactly the reverse to that observed with carbonic acid gas: the nerve was irritable, but could no longer convey impulses coming from its central end. Irritability and conducting power were tested, not only by muscular contractions, but also by the negative variation at the peripheral end of the nerve. Three distinct causes might be assumed for the difference between irritability and conducting power which had been experimentally proved as above. In the first place, irritability and conducting power might be two totally distinct properties of a nerve. But this view must be dismissed, inasmuch as the only possible way of conceiving the propagation of an impulse is to suppose that the impulse is transmitted from one transverse section of the nerve to another, so that the stimulation of one section acts as a stimulus to the rest. In the second place, it might be supposed that the electrical resistance of the nerve-sheath and medullary-sheath had been increased, so that the stimulus, which was applied from the exterior, could not overcome this increased resistance, while at the same time the conducting power of the axis-cylinder remained unchanged. But this view is untenable in face of the fact that alcohol vapour increases the irritability of a nerve but lessens its conducting power. And it is still further opposed by an experiment on the olfactory nerve of the pike. This nerve possesses scarcely any sheath, or at most an extremely thin one, and still it behaved exactly as does a sciatic nerve when surrounded by carbonic acid gas. Finally, mechanical stimuli were just as efficient as electrical, and in this case the resistance of the sheath does not affect the question. A third possible explanation was that nerves possess not only a longitudinal, but also a transverse irritability, and that the latter is diminished by the CO_2, and increased by the alcohol vapour. This last explanation was also rendered probable by an experiment in which the heightened irritability under exposure to alcohol vapour was still further increased when the current used for stimulation was led through the nerve at right angles to its length by means of wide electrodes instead of by means of the wire electrodes usually employed, in which latter case a small longitudinal stretch of the nerve is included between the points of the electrodes. The speaker therefore regards it as proved that the irritability of a nerve can be diminished by the action of CO_2 without its conducting power being simultaneously affected. Further, that by means of alcohol vapour the irritability may be increased, while the conducting power is at the same time considerably diminished, and that nerves possess a distinct transverse irritability. The speaker also regarded it as extremely probable that the effect of CO_2 and alcohol vapour is different upon the transverse and longitudinal conducting powers of a nerve.

VIENNA.

Imperial Academy of Sciences, February 7.—The Secretary read a letter by Dr. Ludolf Griesebach on his travels in Turkistan, describing the geology of the environs of Ghazni.—The following papers were read:—On the retinal image of the insect's eye, by Prof. S. Exner.—On the orbit of Winnecke's comet in the years 1858–86, by E. von Haerdtl.—On the relation of atmospheric pressure to electricity (sealed), by T. Altschul.

February 17.—The following papers were read:—On some derivatives of cyanamide, by A. Smolka and A. Friedrich.—On morphine, by Zd. H. Skraup and Dr. Wiegmann.—On the definitive determination of the plane of polarization, by the late L. Kudelka.—On an anomaly of Mendeleeff's periodic system (sealed), by B. Brauner.—On marine Hydrachnida, with some remarks on Midea (Bruz), by R. von Schaub.—On the passage of electricity through bad conductors, by H. Koller.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Egeson's Weather System of Sunspot Causality: Charles Egeson (Sydney, Turner and Henderson).—The Chemistry of Photography: R. Meldola (Macmillan).—First and Fundamental Truths: J. McCosh (Macmillan).—British Dogs, No. 30: H. Dalziel (U. Gill).—The Dentists' Register, 1889 (Spottiswoode).—The Medical Register, 1889 (Spottiswoode).—A Treatise on Manures: A. B. Griffiths (Whittaker).—Argentine Ornithology, vol. ii.: P. L. Sclater and W. H. Hudson (Porter).—Encyclopædia Britannica, ninth edition, index (Edinburgh, Black).—By Leafy Ways: F. A. Knight (Stock).—An Elementary Text-book of Applied Mechanics: D. A. Low (Blackie).—Journal of the Scottish Meteorological Society, third series, No. 5 (Blackwood).—Deutsche Ueberseeische Meteorologische Beobachtungen, Gesammelt und Herausgegeben von der Deutschen Seewarte, Heft 2 (Berlin).—Journal of the Chemical Society, April (Gurney and Jackson).—Geological Magazine, April (Trübner).—Mind, April (Williams and Norgate).—Himmel und Erde, April (Berlin).

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